SAMPLES AND INSTRUMENT DATA

Parallel Session #6 (Showroom)

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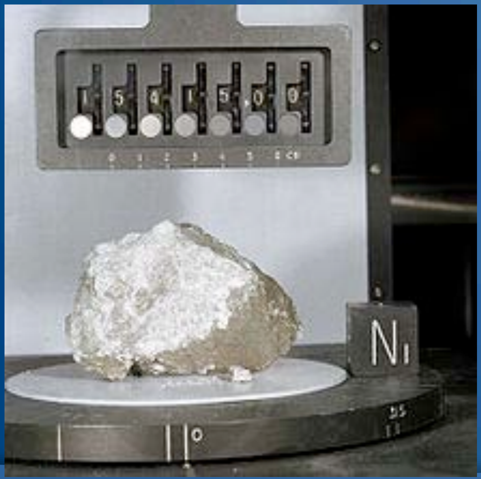
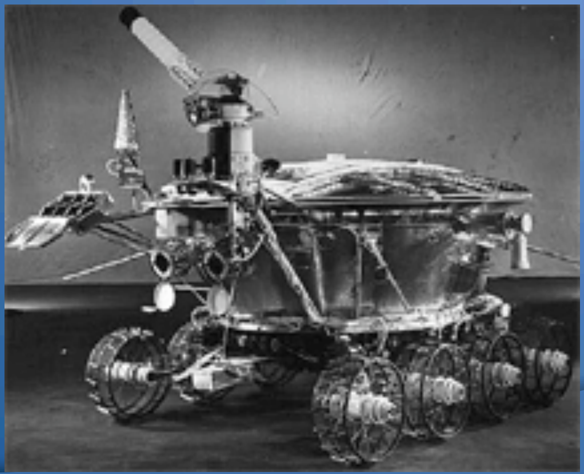
“The gifts that keeps on giving”

- Samples
- Instrument data
- Next Gen scientists/engineers



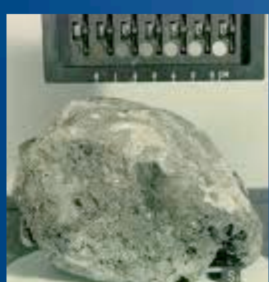


Outline

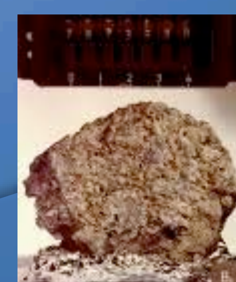
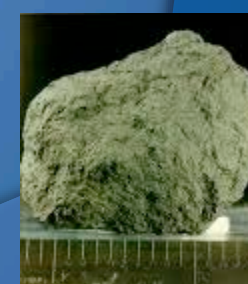
- The continuing value of samples
- Apollo instrument data in the digital age
- The future of lunar curation - Lunar Sample Acquisition and Curation Review results
- A preview of the session

The value of samples

- Superior analytical capabilities
- Not limited by mass, power, reliability, data rate, the requirement to work autonomously, etc
- Can double-check results, compare across labs
- Take advantage of improvements in instruments



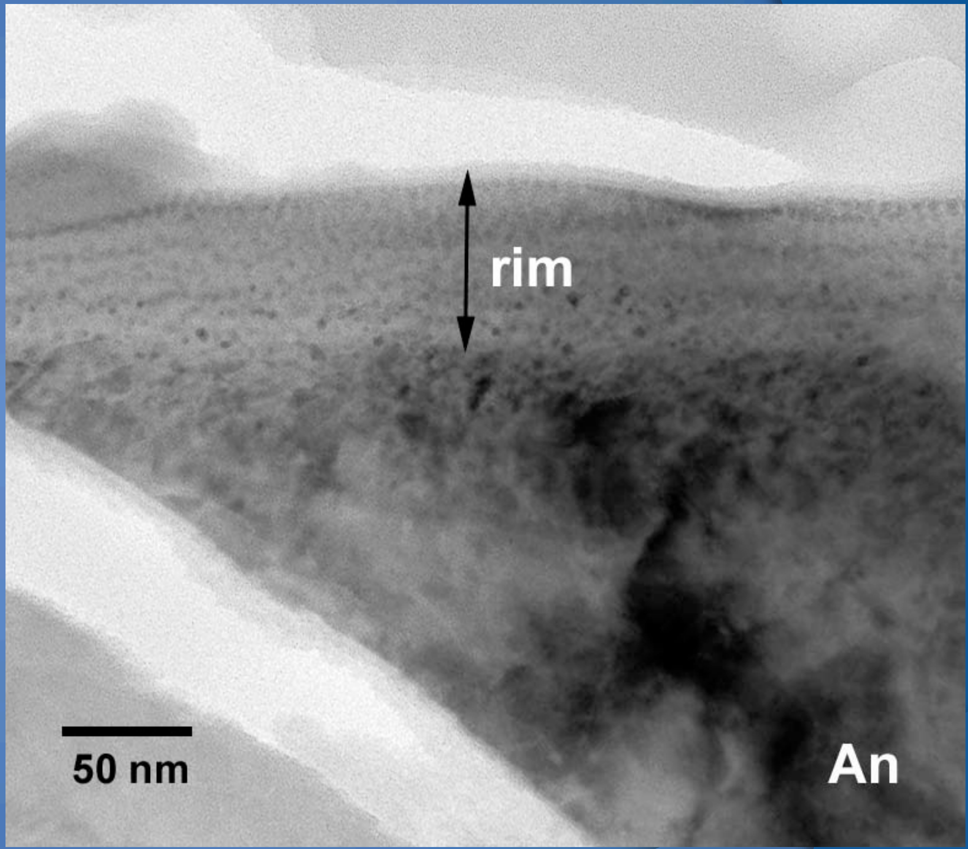


What have we learned lately from lunar samples?

- Space weathering
- Chronology
- Water

Space Weathering



Chronology

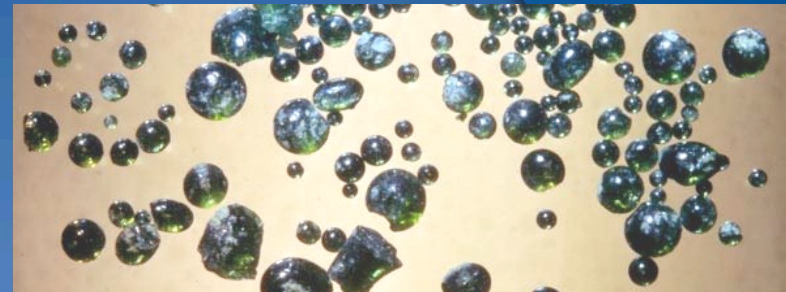
- Youngest basalts
- Farside impact melts
- Possible SPA meteorite?

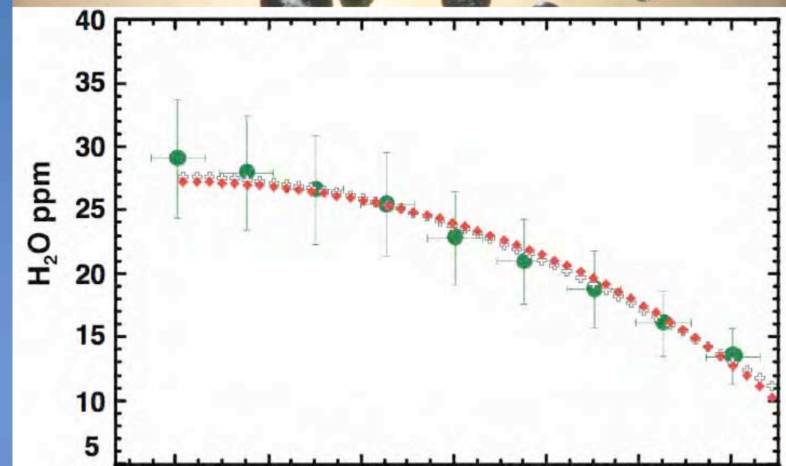
NWA 32

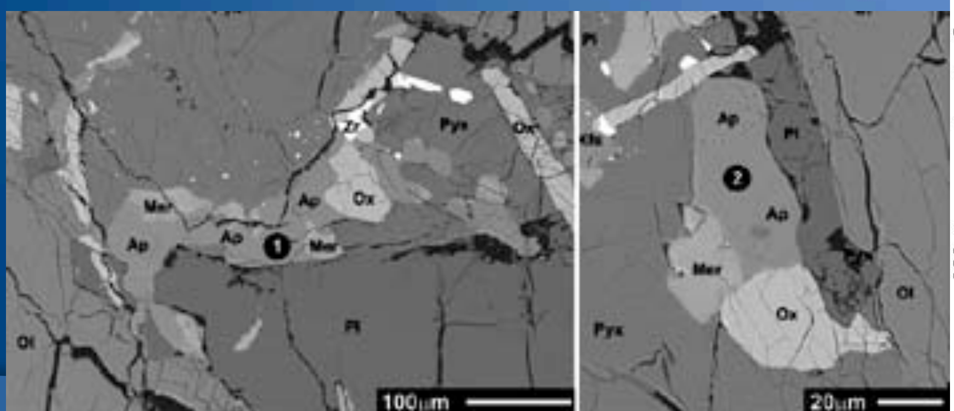
Dhofar 961

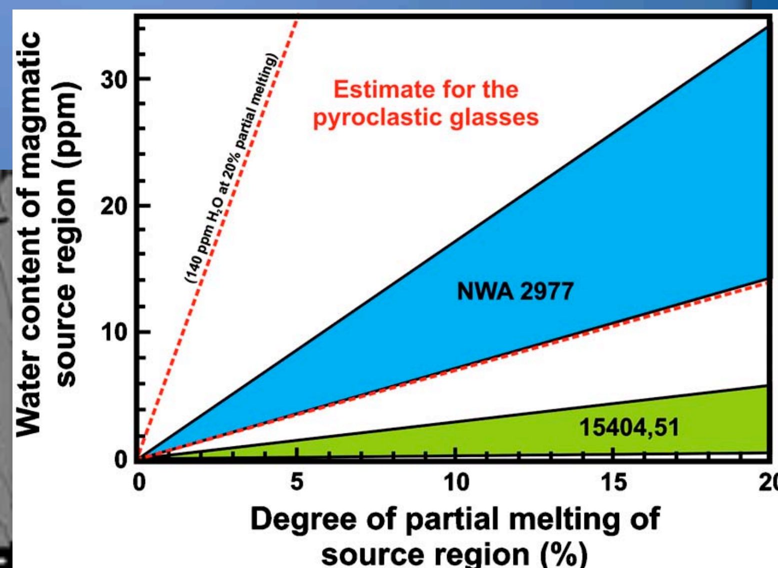
Water

- Saal et al, 2008 Nature
- Liu et al, 2010 LPSC
- McCubbin et al, 2010 PNAS



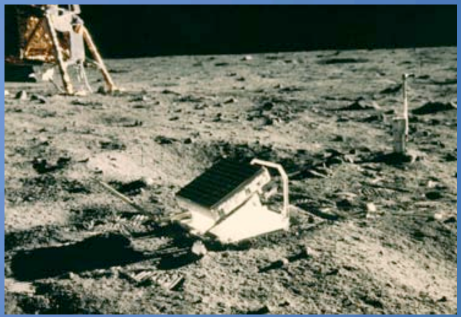






Instrument Data

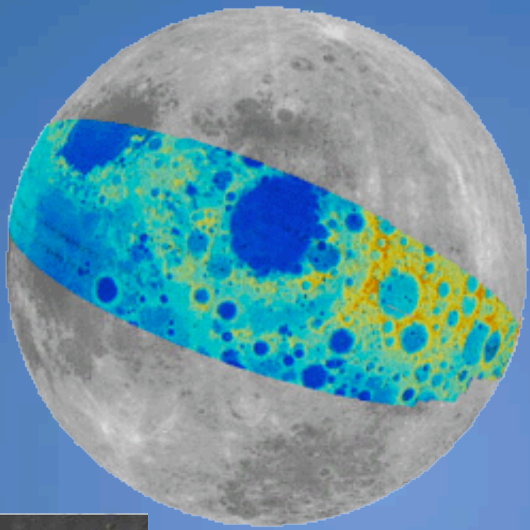
- Seismic Data
  - Advances in computing power have improved analysis of Ap dataset
- Retroreflectors
  - Still providing data!

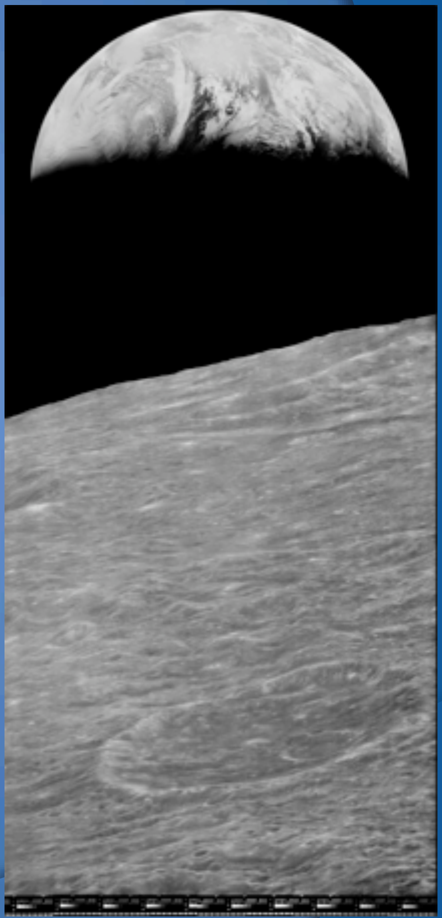


- Imagery
  - Digital scanning of Lunar Orbiter and Ap Metric and PanCam data have improved those datasets and made them available to the community and public

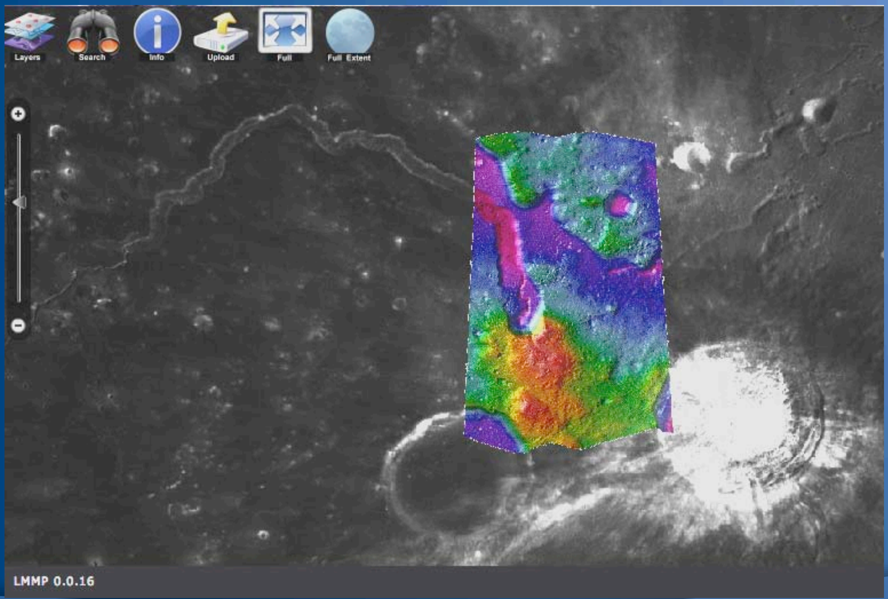
Digitized Apollo imagery

Ap 15 Metric Camera data
DEM (see Nefian et al poster)





Lunar Orbiter Image
Recovery Project



Apollo Pan Cam data DEM of Aristarchus Plateau

The Future of Lunar Curation

Lunar Sample Acquisition and Curation Review (LSACR)

A CAPTEM-LEAG team reviewed the guiding principles for the acquisition and curation of samples during future human lunar surface activities.

- Charles Shearer, Univ of New Mexico, Co-chair
- Clive Neal, Univ of Notre Dame, Co-chair
- Lou Allamandola, Ames Research Center
- Jacob Bleacher, Goddard Space Flight Center
- Jesse Buffington, Johnson Space Center
- Simon Clemett, Johnson Space Center
- Dean Eppler, Johnson Space Center
- Fred Hörz, Jacobs Technology
- Lindsay Keller, Johnson Space Center
- Sarah Noble, Marshall Space Flight Center
- Dimitri Papanastassiou, Jet Propulsion Lab
- Scott Sandford, Ames Research Center
- Allan Treiman, Lunar and Planetary Institute

Ex officio

- Marilyn Lindstrom, NASA HQ
- Carlton Allen, JSC
- Gary Lofgren, JSC
- Karen McNamara, JSC

Contributors

- Judith Alton, JSC
- Mary Sue Bell, JSC
- Cindy Evans, JSC
- John Gruener, JSC

Future lunar curation - LSACR

The review was requested by SMD and OSEWG and covered the following topics:

- The implications of sample acquisition, preservation, return, and curation on critical engineering requirements for Constellation or any other follow-on design for exploration of the Moon or other planetary body
- The need for sample documentation, acquisition, packaging, preservation and contamination control at all stages
- Usefulness of field analysis in sample selection
- Sample acquisition tools and protocols
- Curation, analysis and "high-grading" at the Moon
- Training levels for astronauts and scientists (Jake’s talk yesterday)
- Curation requirements and required facilities on Earth

Future lunar curation - LSACR

- Examined lessons learned from Apollo
- And recent technical advances / improvements
- Identifies 58 findings tied to the acquisition and curation of samples during lunar surface activities.
- An additional 25 findings tied to curation on Earth of extraterrestrial materials.

Future lunar curation - LSACR

- The architecture should be able to accommodate a return mass of 250 to 300 kg of sample and sample containers (per mission). A volume of 0.10-0.12 m^3 is required per 100 kg of lunar samples.
- The usefulness of soft containers to return lunar samples should be explored. A hard Apollo-type rock-box is inefficient at packing samples, increases the volume needed per 100 kg of sample mass, and is inflexible in storage.

Future lunar curation - LSACR

- There is a need to establish programmatically acceptable guidelines for general materials selection and control protocols for specific manufacturing and surface finishing processes to reduce/control contamination.

Contamination Issues:

- Indium (10% Ag) seals in sample containers resulted in indium contamination.
- Apollo 15 drill core were a Ti alloy and threads were canadized in Pb bath.
- Core bit with WC cutters brazed to drill stem (potential W, Ni, Pb contamination issues)
- MoS_2 grease used in LRL up to about 1972. Source for organic contamination
- Xylan (complex blend of organics with PTFE) replaced MoS_2 grease in 1972. Source of N and organic contamination.
- Band saw blade diamonds adhered in electroplated Ni; sawing is dry, causing heating.
- Moisture & oxygen in N_2 usually ~5 ppm, but rises during processing, gloves leak.

Future lunar curation (continued)

- A joint advisory committee consisting of both science and engineering community stakeholders is required to facilitate communication and formal decision making that is required to maintain and enforce the standards established in recommendation 3 (above).
- For all science involving thermally sensitive samples (geology, planetary science, biology) refrigeration units must be accommodated within the returning space craft and the outpost. Cryofreezers providing a level of capability similar to GLACIER, developed for the ISS, are representative of the capacity and level of thermal control required.

GLACIER cryofreezer on ISS can maintain temps of -80C

Future lunar curation (continued)

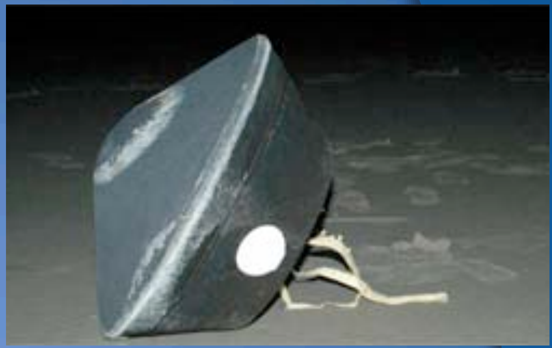
- The scientific exploration of the Moon and associated sampling mandate efficient transfer of voice, navigation, imagery and analytical instrument data from the surface to the ground and vice versa. These needs have detailed implications for the Communication Architecture.
- Reducing sample return mass by "high-grading" samples on the lunar surface that is based on scientific criteria requires well-trained astronauts and key analytical instruments. The former requires well thought out astronaut selection and training, while the latter dictates power requirements for sortie and outpost operations.

Ap15 “Science Back Room”

Modern Science Back Room

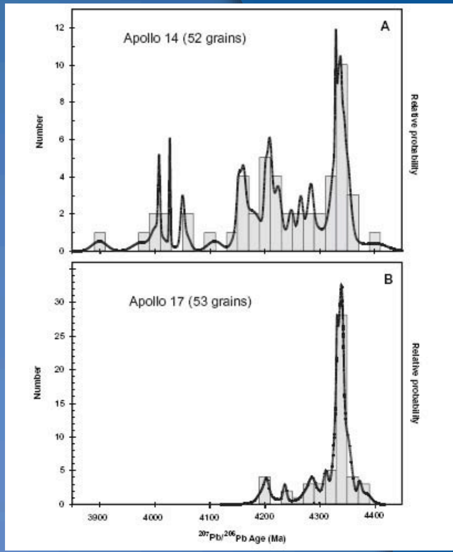
Future lunar curation (continued)

- Curation should be represented at spacecraft landing site and accompany samples back to the curation facility.
- A research and development effort should be initiated for sample containers and sample cabinets for volatiles (potential water and organics).
- The current curatorial facilities will be at full capacity with the return of 450-500 kg of materials from future lunar sample return missions (but with some juggling of samples to WSTF and more efficient cabinets, maybe 1000-1200 kg)



Session lineup

- **Charles Byrne** - Absolute Zircon Ages for Pre-Nectarian Events and a Proposed Age for the Near Side Megabasin



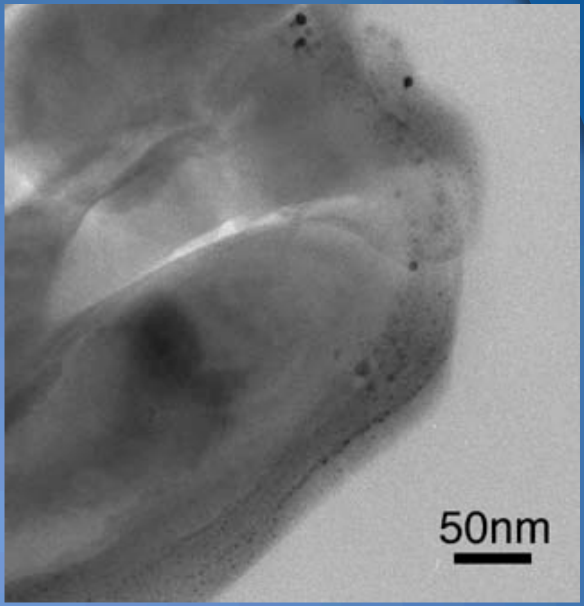
- **Amy Fagan** - Apollo 16 Sample 60635: Evidence for assimilated KREEP-rich material?

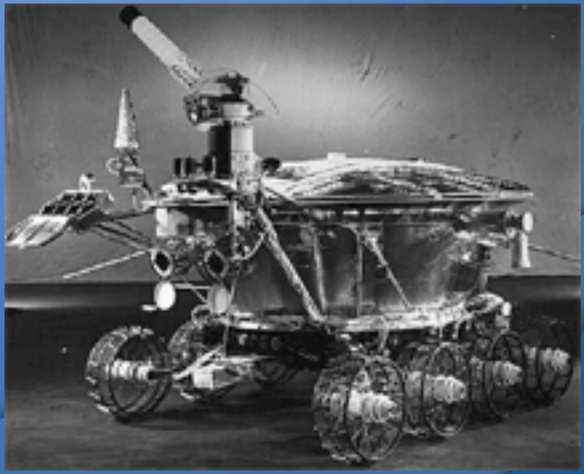
Session lineup

- **Dimitri Papanastassiou** - Re-determining Rb-Sr ages of Apollo 16 impact melt rocks: Implications for sample return from SPA
- **Chip Shearer** - Analysis of Samples from Regolith in the Moon's South Pole-Aitken Basin, Using Basalts to Probe the Interior of the Moon

Session lineup

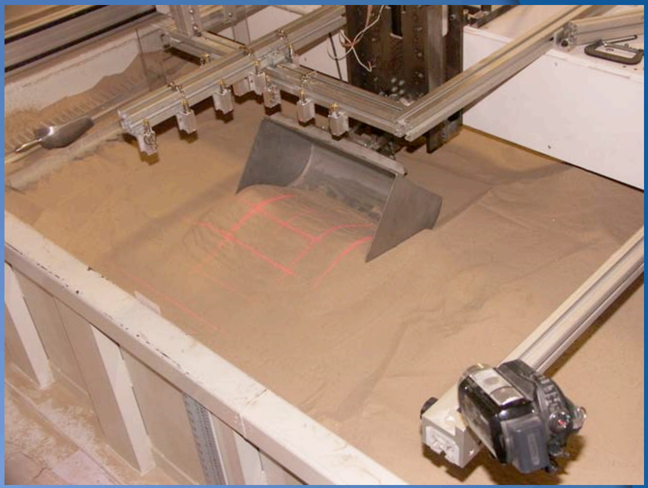
- **Shouliang Zhang** - Quantification of nanophase iron metal in the silicate rims from lunar soil
- **Tom Murphy** - The Lunokhod 1 reflector and what it means for lunar ranging





Session lineup

- **Jerome Johnson** - Lunar Regolith mobility and excavation modeling



- **Noah Petro** - Next Generation Lunar Scientists and Engineers Workshop 2010: Results and Feedback